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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

De La Rue International Limited
De La Rue House, Jays Close
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GREAT BRITAIN

Patents ADP number *(if you know it)* 7563612001

If the applicant is a corporate body, give the country/state of its incorporation — Great Britan

4. Title of the invention — SECURITY DEVICE

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Gill Jennings & Every

Broadgate House
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London
EC2M 7LH

Patents ADP number *(if you know it)* 745002

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
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| | | |

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8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

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Answer YES if:

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| | |
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| Continuation sheets of this form | |
| Description | 12 |
| Claim(s) | 4 |
| Abstract | |
| Drawing(s) | 6 +6 |

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| | |
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| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent (Patents Form 7/77) | |
| Request for a preliminary examination and search (Patents Form 9/77) | |
| Request for a substantive examination (Patents Form 10/77) | NO |
| Any other documents (please specify) | |

11. I/We request the grant of a patent on the basis of this application.

For the applicant
Gill Jennings & Every

Signature [signature] Date 20/02/04

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SKONE JAMES, Robert Edmund
020 7377 1377

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# SECURITY DEVICE

The invention relates to a security device and a method for making such a security device. The invention is particularly concerned with security devices for documents of value such as banknotes, certificates and the like.

It is well known to provide security devices in the form of holograms and diffraction gratings using surface relief structures. However, an alternative class of security device is based on non-diffractive line structures, that is structures which produce an optically variable effect when the angle of incidence of light varies but in which this effect is not caused by interference or diffraction.

An example of such a structure is described in WO 94/29119. In this case, a variety of line structures are embossed into a transparent, plastics substrate, the embossed lines defining regions in which the lines extend at different angles to each other and define different shapes that are visible to a greater or lesser extent upon transmission and reflection of light as the substrate such as a banknote is tilted, rotated or viewed from different angles.

WO 90/02658 describes a security device in which one or more transitory images are embossed into a reflective surface.

WO 98/20382 discloses a further security device in which groups of elemental areas in which lines extend at different angles from each other form respective image pixels.

Finally, US-A-1996539 discloses a decorative device in which a relief structure is formed in a surface and has an optically variable effect.

There is a need to improve upon the known devices to increase their security.

In accordance with a first aspect of the present invention, a security device comprises a substrate having

a reflective surface portion which is provided with a raised line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel raised lines, the lines of at least three segments extending in different directions, each line carrying an ink which does not extend fully into the spaces between the lines or which is sufficiently translucent between the lines so as not to obscure the reflective surface between the lines, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

In accordance with a second aspect of the present invention, a method of manufacturing a security device comprises providing a reflective surface portion of a substrate with a raised line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel raised lines, the lines of at least three segments extending in different directions, and providing each line with an ink which does not extend fully into the spaces between the lines or which is sufficiently translucent between the lines so as not to obscure the reflective surface between the lines, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

We have realized that it is possible to achieve additional effects by combining accurately, one or more colours with the raised lines in such a way that the reflective portions of the lines which are not covered by the ink provide an optically variable effect in conjunction with the absorptive/reflective effect of the ink. Thus, the colour of the ink can be used to change the overall appearance of the (specularly) reflective background. For example, a green ink could be printed over a silver background to create the effect of having a green specularly reflective surface.

The use of 3 or more segments enables a movement effect to be achieved. Ideally, many segments should be used with lines extending in different directions to ensure that reflected light is visible at substantially all viewing angles. To that end segments containing lines extending at say 10°, 20°, 30° etc to some nominal direction are preferred.

The lines are preferably embossed or debossed into the substrate. The embossing process is preferably carried out using an intaglio plate having recesses defining the line structure which are filled with the ink so that the lines and ink are simultaneously provided in register.

However, in an alternative approach, the lines of ink could be printed onto the unembossed reflective surface which is subsequently embossed in register. The former approach is preferred since registration is more simply achieved.

The invention also extends to non-embossed raised lines produced for example by screen or thermographic printing. Here an ink film is applied in such a thickness that it has a relief, in the case of UV printed screen inks this could be comparable to depth of relief achievable by intaglio.

The lines within each segment can take any convenient form including straight (rectilinear) or curved such as full or partial arcs of a circle or sections of a sinusoidal wave.

The lines may be continuous or discontinuous and, for example, formed of dashes, dots or other shapes. By other shapes we mean the dots or dashes could have a graphical form. For example microtext printed at a size of 12 microns will appear as continuous lines when viewed with the naked eye. Under closer inspection using an eye glass the apparent continuous line can be visualised as text. The microtext could be alphanumeric characters, logos (e.g. trademarks), geometric shapes and the like.

The sides of the lines typically extend at an angle offset from a normal to the surface.

The lines within a segment typically have substantially the same width and/or height and/or pitch but one or more of these could vary.

A particularly preferred example involves providing a region in the feature design on the intaglio plate which is deeper compared to the remainder of the feature design. This will in turn equate to a region that has a greater relief when printed.

The line widths are typically in the range 10-300 microns, preferably 50-150 microns. The space between the lines is typically 10-300 microns. The line width to space ratio is typically 3:1 to 1:2 but preferably 2:1; i.e. for a line width of 70 microns, the space would be between 23 and 140 microns, preferably 35 microns.

The line segments may or may not be individually discernable to the unaided naked eye. Preferably, the individual lines are barely visible to the naked eye, the main visual impression being given by the segments and the combined effect thereof.

Each segment can take any shape or form, for example square, triangle, hexagon, star, flower or indicia such as a letter or number. The segments may tessellate or nest.

In some cases, the segments may be outlined with a continuous printed or non-printed perimeter line or the outline may simply be defined by the extent of the embossed lines.

The segments will typically abut although in some cases they may be spaced apart. The space between adjacent segments is typically in the range of 20 microns to 2mm. Alternatively, the segments could overlap and in a particularly preferred approach the segments are nested one within another. This latter arrangement is particularly preferred where each segment defines a similar shape. In the most preferred example, the nested shapes are rotated relative to one another.

In another example, the segments within the security device define a range of different shapes and, for example, might comprise a combination of triangles and rhombi.

The unprinted areas could define additional information such as alphanumerics.

Where the segments are spaced apart, the plain areas between them may be of a similar shape to that of the segments.

The segments may also be arranged into larger shapes including, for example, geometric shapes, flowers, numbers or letters.

The specularly reflective portion of the substrate may be formed by a foil, metallic ink, metallic coating, iridescent coating, glossy varnish, hologram, high refractive index or optical effect film. By optical effect film we mean for example multilayer iridescent film. The surface portion can be solid or discontinuous and, for example, may contain spaces with or without a coloured print underneath.

Typically, the specularly reflecting portion can be any colour, for example silver or gold, and where specularly reflecting inks are used, these will generally give a general appearance, which is not as highly reflecting as specular mirror surfaces but a distinctive sheen.

The raised line structure may extend beyond the reflective portion and/or the reflective portion may extend beyond the raised line structure.

The substrate is typically paper although other known substrates such as plastics could also be used. It is known that an improved metallic effect (whether this be via printing or foil transfer) can be achieved on a smooth substrate. With this in mind plastic substrates are likely to show a strong metallic effect but are less likely to emboss as well as paper. As an alternative a paper substrate could be primed to improve its surface finish. By priming we mean the paper could be coated or calendared

prior to application of a metallic ink/foil layer. As a further alternative the foil/metallic ink could be calendered after application to the paper surface. This has a polishing effect again improving the reflectivity of the metallic surface. This polishing will occur to some extent anyway as part of the intaglio process. Where the flat smooth, uninked areas of the intaglio plate come into contact with the metallic foil/ink they polish the foil/inks surface.

In an important aspect, where the lines are formed using an intaglio plate, further intaglio printing or blind embossing may be carried out using the same intaglio plate so as to achieve precise registration between the different components. Indeed, in some cases, some of the recesses defining the security device may be filled with ink and others left unfilled.

The colour of the ink or pigment used may match the colour of the specularly reflective surface. Preferably, however, the colour of the ink or pigment contrasts with that of the specularly reflective surface. The advantage of this is that as the viewing angle and/or illumination angle changes, different segments become more strongly visible. This leads to the appearance of having two or more different colours simultaneously and is a very cost effective way of achieving an optically variable effect.

In preferred examples using embossed or debossed line structures, the ink is provided on the lines and does not extend into the spaces between the lines. However, it is possible for the ink to extend between the lines if it is sufficiently thin so as to be translucent.

In accordance with a further aspect of the present invention, a security device comprises a substrate having a reflective surface portion which is provided with a raised (preferably embossed or debossed) line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel raised lines, the lines of at least three segments

extending in different directions, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

In this aspect of the invention, the raised lines remain uninked but, by providing at least three segments, a secure device is achieved.

The security device may be embodied as a label such as a transfer label which can then be adhered to a document of value. Alternatively, the substrate of the security device could also constitute the substrate of a document of value.

Some examples of security devices according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic representation of a banknote bearing a security device according to the invention;

Figure 2 illustrates schematically and in enlarged form part of the security device shown in Figure 1;

Figure 3 is a schematic cross-section through part of a segment of the device shown in Figure 2;

Figure 4 illustrates schematically and in enlarged form a further device according to the invention;

Figures 4A-4C illustrate the appearance of the security device of Figure 4 when illuminated from three different directions;

Figure 5A-5H illustrate examples of segments of lines;

Figures 6A-6C illustrate further examples of the device according to the invention;

Figures 7 and 7A-7C illustrate nested arrangements of segments of lines;

Figure 8 shows a further device;

Figures 9A-9E illustrate different stages in the production of the Figure 3 device; and,

Figures 10A-10D illustrate four further devices.

Figure 1 illustrates a banknote formed on a paper substrate 1 and carrying printing of a conventional type and in addition carrying an example of a security device 2 according to the invention. In this case, the security

device 2 has been intaglio printed directly onto the reflective portion of the banknote substrate and another part of the same intaglio printing plate has been used to print, at the same time, an image indicated schematically at 3 so that this image is automatically and accurately registered with the device 2.

Figure 1 shows the feature in the context of a banknote design with the feature numbered 2 and other printed intaglio regions numbered 3. Further to these printed intaglio regions other regions could be provided as uninked embossed areas, such as described in WO90/02658. Figure 2 illustrates the device 2 in enlarged form. It will be noted that the number 2000 is not printed and it is also not embossed. This is a non-printing area on the intaglio plate within the area of the design. In addition, the device includes a first border made up of several indicia "2000" which are non-embossed, and an outer decorative border. All these regions are in register and printed from the same intaglio plate.

As explained above, the security device 2 can take a variety of forms and Figure 4 illustrates one example. In this example, the security device is made up of a variety of triangular 4 and square 5 shaped segments which are tessellated together. In this case, although a perimeter line is shown around each shape, this is, in fact, simply defined by the ends of the parallel lines making up the segments. The segments are each defined by a set of substantially parallel lines with the lines of different segments being angularly offset from one another.

The top portion of each embossed line is covered with an ink as shown in Figure 3. Thus, each embossed line is indicated at 6 with the ink at 7. As can be seen, the sides of each line are at an acute angle to a normal to the substrate and the valleys 8 between the summits of the lines 6 are free of ink but are reflective.

Figures 9A-9E illustrate different stages in the intaglio printing of the portion shown in Figure 3.

Initially, an intaglio plate 20 having recesses 21 is coated with ink 22, the ink filling the recesses 21 and providing a surplus on the surface of the plate 20. This surplus is then wiped away in a conventional manner (Figure 9B) and the substrate 1 placed onto the inked plate (Figure 9C). Pressure is then applied between the plate 20 and substrate 1 (Figure 9D) causing the substrate to enter the recesses 21. The substrate is then removed and draws with it most of the ink 22 contained within the respective recesses 21 but leaving a small remainder as can be seen in Figure 9E. The resultant, printed substrate has the form shown in Figure 3.

Another example of a security device is shown in Figure 4 and its appearance under different lighting conditions is shown in Figures 4A to 4C. Thus, in Figure 4A, the light is incident in a direction 10 and this will be reflected by the segments 5A and 4A-4D. This is because the lines in these segments extend at or near 90° to the incident light direction.

When the incident light direction is rotated to a direction 11 (Figure 4B), a different set of segments appears bright. In this case, the segments include segments 5B and 4E. Some of the segments appear less bright while the remaining segments appear dark. Again, this brightness depends upon how close the lines defining the segment extend at 90° to the incident light direction 11.

Figure 4C illustrates a further angle of incidence 12 in which segments 4F-4M appear bright with the remaining segments appearing dark.

If the ink 7 is chosen to have a colour which contrasts with the reflective surface of the substrate 1 into which the lines have been embossed then the dark segments will exhibit the colour of the ink 7 in each case. Thus, as the security device 2 is rotated relative to the incident light direction, the triangular shaped areas will switch on and off giving rise to an appearance of movement

across the device. This is a novel effect which is relatively easily detected by a user thus making it particularly suitable as a security device. Nevertheless, it is difficult to reproduce fraudulently. Thus this feature is much easier to authenticate than the latent type structure. It can also be easily located. As a secondary benefit, more with respect to OVD's, it is relatively cheap. As the feature can be produced using the existing litho and intaglio processes, the use of costly optically variable foils is avoided.

A typical segment size is 2mm by 2mm or an equivalent area. By equivalent area we include the fact that the segment could be long and thin and could be a line bordering an area. For example in Figure 9 each "segment" is essentially a line around a square. In the figure drawn real size one can see that the width of this line is not that great but the line is quite long. Essentially the segments should be of a size and shape such that they can be visualised with the unaided eye. That is one should be able to discern the changing visual impression of each segment as viewing angle changes.

Figures 5A to 5H illustrate a variety of other shapes which the segments can take. Figures 5A-5C show segments with a printed or non-printed perimeter line in register with the embossed lines while Figures 5G and 5H show segments bounded only by the extent of the parallel lines.

Figures 6A-6C illustrate further examples of arrangements of segments.

Figure 7 illustrates an example of the security device in which a set of hexagons are nested one within the other, each hexagon being rotated relative to the immediately adjacent inner and outer hexagons. Each hexagon is defined by a set of lines with the angles of the lines being different and also their line widths and pitches. As this security device is rotated, it will appear as a rotating hexagon which diminishes or expands in size. This is a particularly attractive but secure feature.

Figures 7A-7C illustrate further examples of nested segments. Figure 7A shows a device with nested and rotated segments, the segments provided with a printed perimeter line. Figure 7B shows a device with nested and rotated segments, the segments not provided with a perimeter line. Figure 7C shows a device with nested and rotated segments, the segments provided with an unprinted perimeter line.

In the next example, a region is provided in the feature design on the intaglio plate which is deeper compared to the remainder of the feature design. This will in turn equate to a region that has a greater relief when printed. To explain this, consider the design of security device shown in Figure 8. The design shown in Figure 8 comprises two elements: a background of nested segments all rotated with respect to each other, and a central numeral 1. In this simple example the central numeral 1 can be originated such that the intaglio plate was deeper in this area compared to the surrounding nested segments. In a different example, using a structure such as that shown in Figure 6B, a latent effect is created. Here the feature comprises only a series of nested segments rotated with respect to each other with no apparent secondary element. Indeed if originated as per normal practice one would still only have the one feature as already described. But it is possible to selectively produce deeper regions on the plate and thus produce an area in a defined shape (say a numeral 1) that is deeper than the surrounding area. This would not be readily recognisable under normal viewing but should be viewable when the device is viewed at an acute angle. One example of how this might be achieved using the polymer process is given below.

a. Exposure through the (moving image) line structure film work onto photopolymer as usual.

b. Carry out a first wash out of say 10 seconds to give a depth of, for example, 50 microns to produce a photopolymer with the moving image

line structure having a nominally consistent depth of 50 microns.

c. Carry out a second exposure using a solid design; say a numeral 1 or a pattern. The photopolymer will be hardened everywhere except where masked by the numeral 1 or pattern.

d. Carry out a second wash out. Where the plate has been hardened further no further washing out of the photopolymer occurs however in the numeral/pattern region which was subject to the further exposure additional photopolymer is washed out resulting in a deeper engraving say 70 microns.

As explained above, where intaglio printing is used to produce the security device, it is possible to provide uninked embossed areas as well as printed ink areas using the same plate.

Figure 10 illustrates some further examples of banknotes (shown schematically) carrying security devices. In Figure 10A, the device comprises a single star shape as for example shown in Figure 5D.

Figures 10B-10D illustrate examples made up of smaller devices arranged in design such as a diagonal, vertical or circular line.

CLAIMS

1. A security device comprising a substrate having a reflective portion which is provided with a raised line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel raised lines, the lines of at least three segments extending in different directions, each line being formed by or carrying an ink which does not extend fully into the spaces between the lines or which is sufficiently translucent between the lines so as not to obscure the reflective surface between the lines, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

2. A device according to claim 1, wherein the substantially parallel lines within a segment are straight or curved.

3. A device according to claim 1 or claim 2, wherein the substantially parallel lines within a segment are discontinuous.

4. A device according to any of the preceding claims, wherein the substantially parallel lines of adjacent segments extend in different directions.

5. A device according to any of the preceding claims, wherein the substantially parallel lines within a segment have substantially the same width and/or height and/or pitch.

6. A device according to any of the preceding claims, wherein the segments have the same shape.

7. A device according to any of the preceding claims, wherein the segments define geometric shapes or alphanumeric indicia.

8. A device according to at least claim 6, wherein the segments defining the same shape are nested one within the other.

9. A device according to claim 8, wherein the segments are rotated relative to one another.

10. A device according to any of claims 1 to 7, wherein a group of the segments are defined and arranged relative to one another so as to define an image such as a geometric shape or alphanumeric indicia.

11. A device according to any of the preceding claims, wherein the segments abut one another.

12. A device according to any of the preceding claims, wherein the ink colour (or colours) is different from the colour of the reflective portion.

13. A device according to any of the preceding claims, wherein the raised line structure is embossed or debossed into the substrate.

14. A device according to claim 13, wherein parts of the lines are uninked.

15. A device according to any of the preceding claims, wherein the reflective portion is formed by one of a foil, metallic ink, metallic coating, iridescent coating, glossy varnish, hologram or holographic coating.

16. A device according to any of the preceding claims, wherein the reflective portion is discontinuous.

17. A device according to any of the preceding claims, wherein the line widths are in the range of 10-300 microns, preferably 50-150 microns.

18. A device according to any of the preceding claims, wherein the space between adjacent lines is in the range 10-300 microns.

19. A device according to any of the preceding claims, wherein the line width to space ratio is typically 3:1 to 1:2, preferably 2:1.

20. A device according to any of the preceding claims, wherein the raised line structure extends beyond the reflective portion.

21, A device according to any of the preceding claims, wherein the reflective portion extends beyond the raised line structure.

22. A device according to any of the preceding claims, wherein the device further comprises a printed border.

23. A device according to claim 22, wherein the border is in register with the raised line structure.

24. A device according to claim 23, wherein the border and raised line structure have been printed using different parts of the same printing plate.

25. A device according to any of the preceding claims, wherein the substrate comprises one of uncoated paper, coated paper, and a polymer.

26. A device according to any of the preceding claims, wherein the substrate forms part of a document of value.

27. A document of value carrying a security device according to any of claims 1-25.

28. A document of value according to claim 27, wherein the security device is adhered to the document.

29. A device or document of value according to any of claims 26 to 28, wherein the document of value comprises a banknote.

30. A method of manufacturing a security device, the method comprising providing a reflective surface portion of a substrate with a raised line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel raised lines, the lines of at least three segments extending in different directions, and providing each line with an ink which does not extend fully into the spaces between the lines or which is sufficiently translucent between the lines so as not to obscure the reflective surface between the lines, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

31. A method according to claim 30, wherein the lines are embossed, the embossing step being carried out using an intaglio plate having recesses defining the line structure which are filled with the ink.

32. A method according to claim 30 or claim 31, wherein the printing plate used to define the lines also defines a further image separate from the security device.

33. A method according to any of claims 30 to 32, for manufacturing a security device according to any of claims 1-29.

34. A security device comprising a substrate having a reflective portion which is provided with a raised line structure, the line structure defining a plurality of segments, each segment being formed by a respective set of substantially parallel embossed lines, the lines of at least three segments extending in different directions, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

35. A banknote carrying a security device according to any of claims 1 to 29 or 34, or manufactured according to any of claims 30 to 33.


FIG : 1

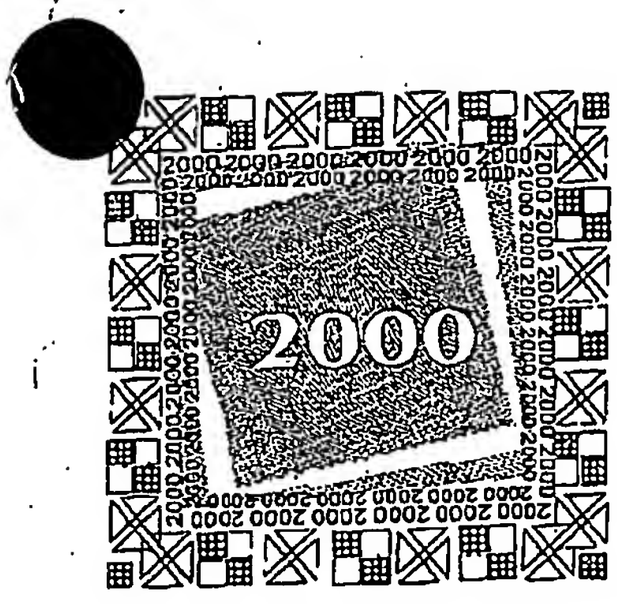



Figure 2

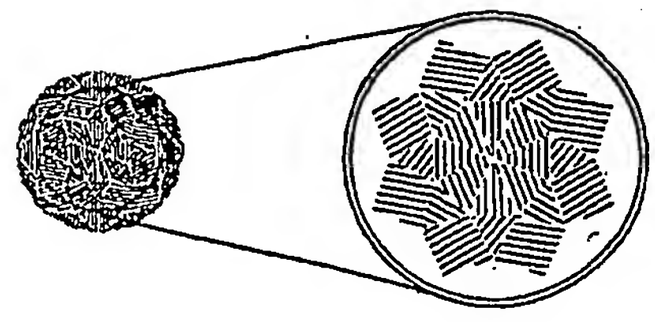
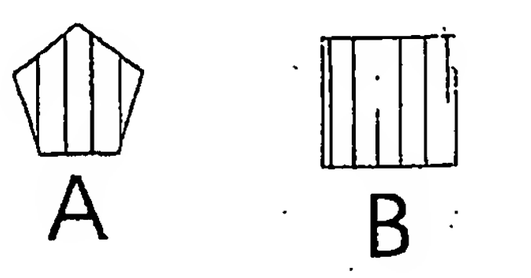


Figure 4

Figure 5



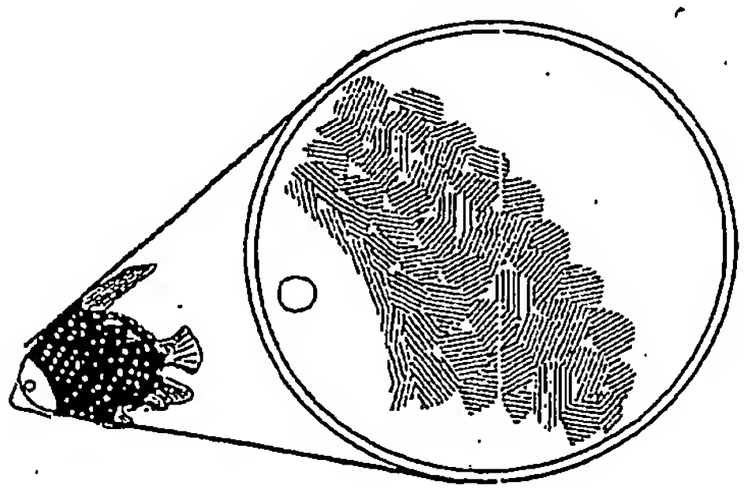



Figure 6A

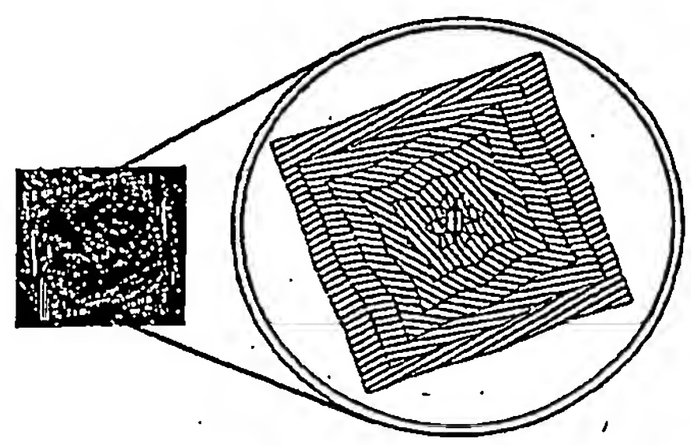


Figure 6B

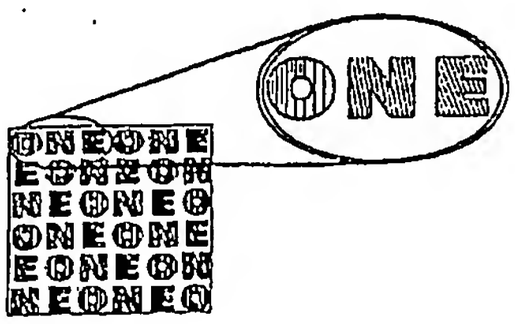
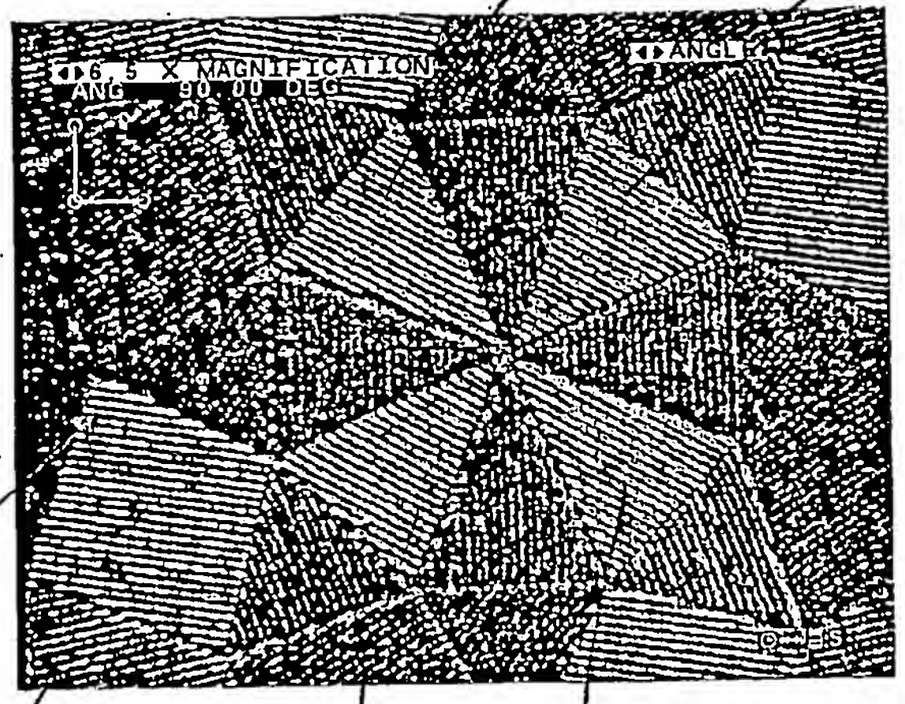
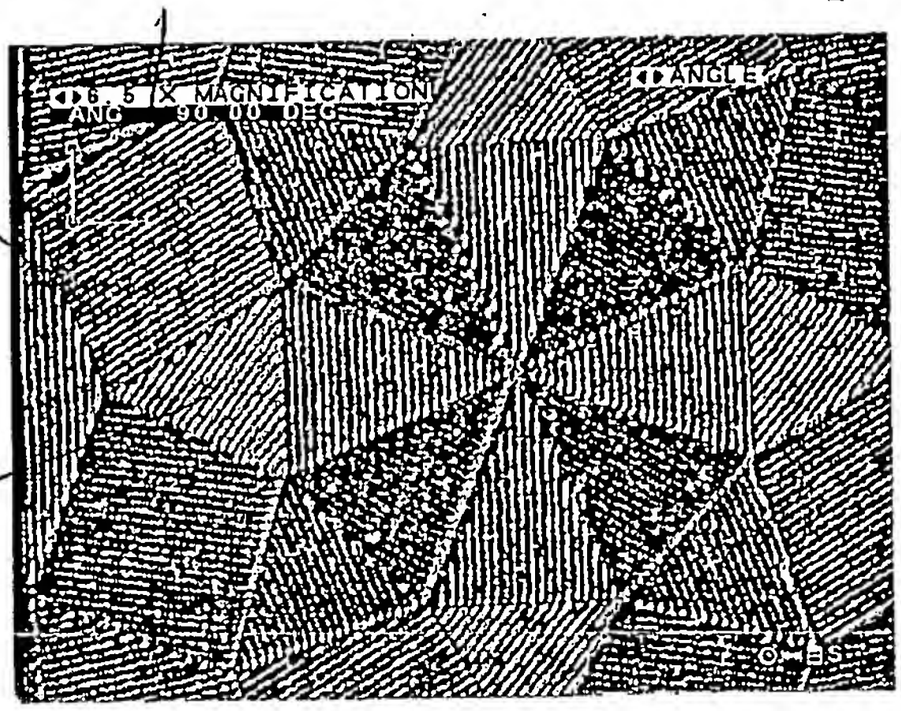


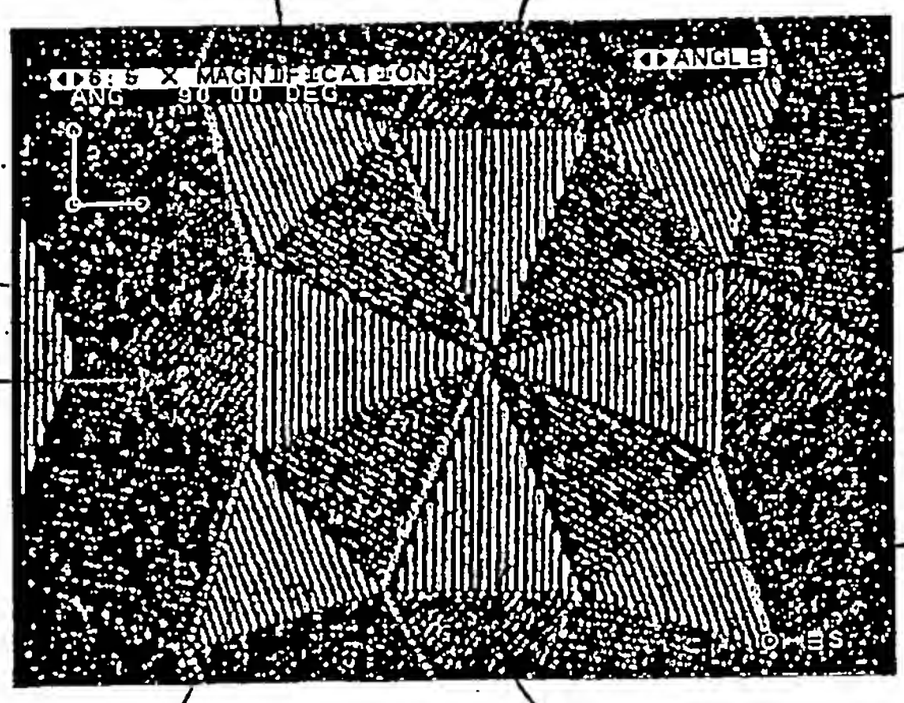

Figure 6C




4A 4B light 10 5A 5B 4C 4D (A)




light 1 11 4E (B)




4H 4I 4G light 12 4F 4J 4K 4L 4M (C)

FIG 4

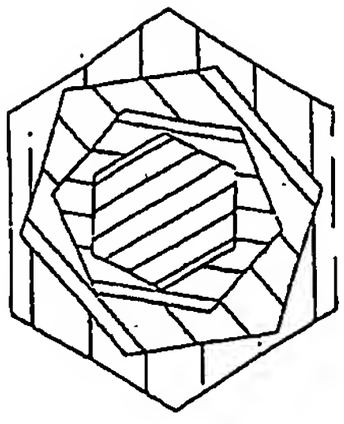


Figure 7

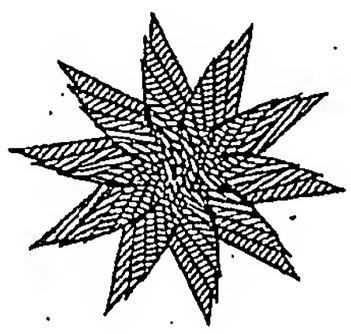


Figure 7A

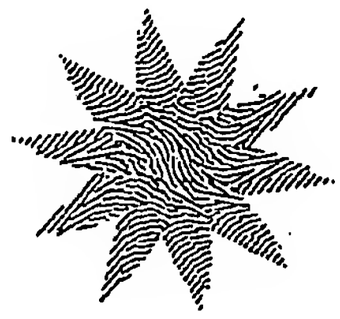


Figure 7B

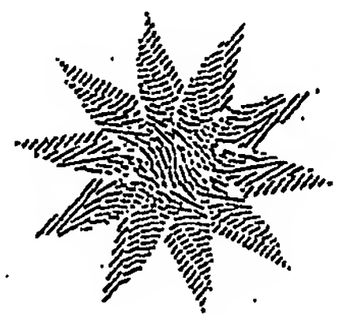


Figure 7C

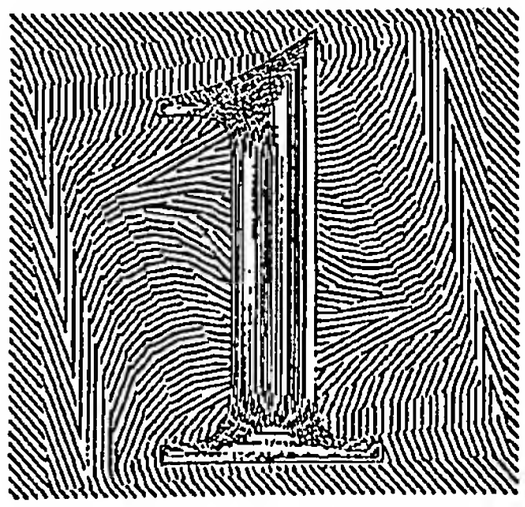
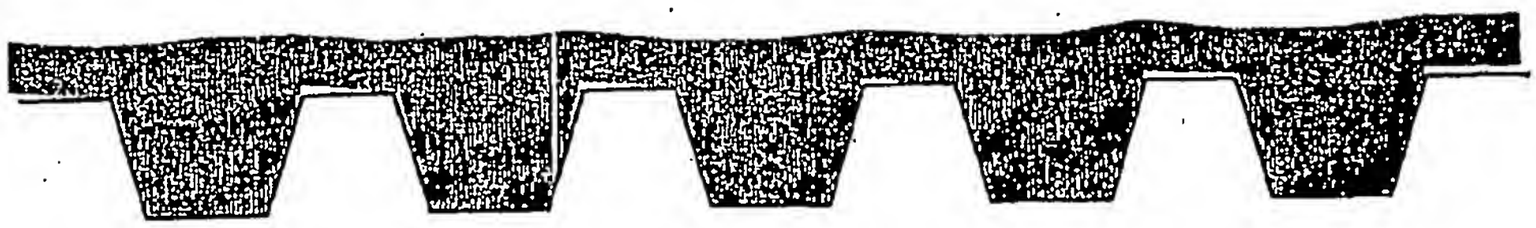


Figure 8

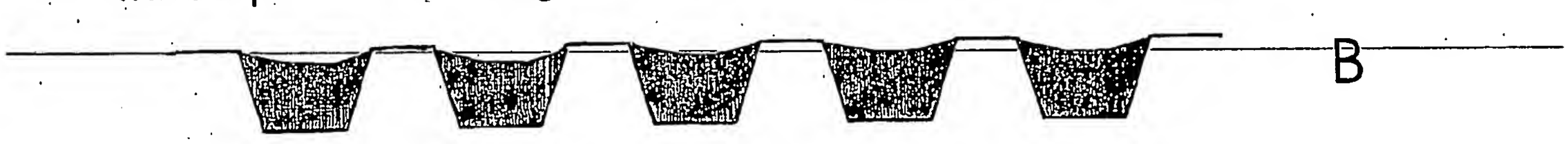
Figure 9

Plate filled with ink



A

Inked plate following wiping



B

Substrate placed onto inked plate

C

Pressure applied

D

Substrate removed - some ink remains in plate

E

Ink on substrate

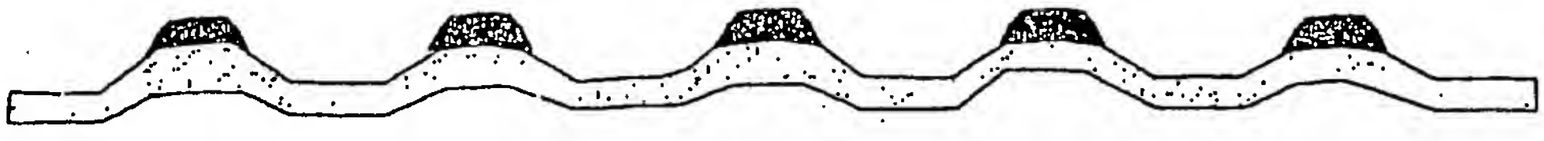


Figure 3

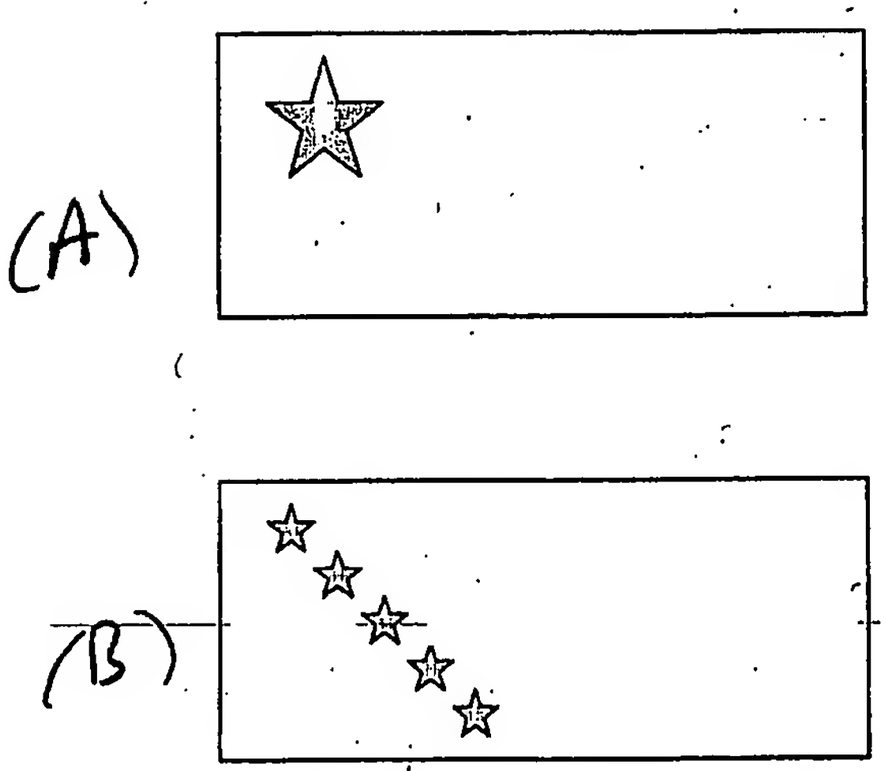




FIG 10

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(54) Title: SECURITY DEVICE


(57) Abstract: A security device comprises a substrate (40) having a reflective portion which is provided with a raised line ,structure (6), the line structure defining a plurality of segments (4a,5a...), each segment being formed by a respective set of substantially parallel raised lines. The Mines of at least three segments extend in different directions. Each line is formed by or carries an ink (7) which does not extend fully into the spaces (8) between the lines or which is sufficiently translucent between the lines so as not to obscure the reflective surface between the lines, wherein each segment causes incident light to be reflected non-diffractively in a variable manner as the angle of incidence changes.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*